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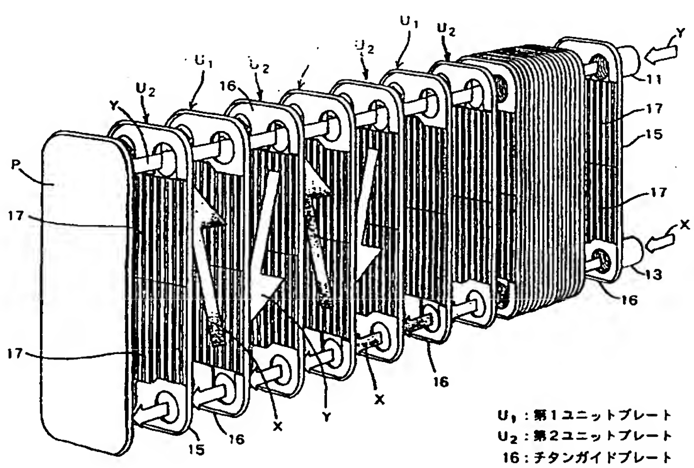
(54) Title: TITANIUM-MADE PLATE-TYPE HEAT EXCHANGER AND PRODUCTION METHOD THEREFOR

(54) 発明の名称: チタン製プレート型熱交換器及びその製造方法



U1...FIRST UNIT PLATE
U2...SECOND UNIT PLATE
16...TITANIUM GUIDE PLATE
17...TITANIUM PLATE FIN

(57) Abstract: A titanium-made plate-type heat exchanger characterized in that, when forming, by joining titanium-made composition members, flow paths in a heat exchanger having first-fluid flow paths and second-fluid flow paths arranged alternately to effect heat exchanging between the two fluids, a Ti-Zr based brazing filler metal containing 20-40 wt.% of Ti and 20-40 wt.% of Zr and being melted at up to 880°C is applied to the joint portions of respective composition members, and they are heated at up to 880°C in vacuum and/or inert gas atmosphere; and a production method therefor; the deterioration of titanium composition members in a heat exchanger due to high-temperature heating at brazing being prevented.

(57) 要約: 第1流体の流路と第2流体の流路が交互に配置されて、両流体の間で熱交換が行われる熱交換器の、前記流路をチタン製構成部材の接合によって形成する際に、各構成部材の接合部に、880℃以下の温度で溶融する、Ti20〜40重量%、Zr20〜40重量%のTi-Zr系ろう材を塗布し、これを真空及び/又は不活性ガス雰囲気の下で、880℃以下の温度で加熱する

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PATENT SPECIFICATION

PRODUCTION METHOD OF TITANIUM-MADE PLATE-TYPE HEAT EXCHANGER

[Field of the Invention]

The present invention relates to a production method of a titanium-made plate-type heat exchanger.

[Related Art]

A conventional titanium-made plate-type heat exchanger is disclosed in Japanese laid open patent No.2002-35929. In the heat exchanger by this invention, herringbone patterned titanium plates are layered such that herringbone patterns of the neighboring plates are arranged in opposite directions each other, and first-fluid flow paths and second-fluid flow paths formed by gaps between the two neighboring plates are alternately arranged so that heat is exchanged between the two fluids.

The above-mentioned heat exchanger is produced according to the following steps: positions to be connected on respective herringbone plates are coated with or filled by a brazing solder; the coated or filled plates are placed in a vacuum heating furnace and the plates are degassed as reducing the pressure of the furnace and gradually raising the temperature of the furnace; and after a required reduced pressure is attained, coated or filled positions are brazed by heating the plates over 850℃.

However, the conventional titanium-made plate-type heat exchanger has the following problems.

(1) Since herringbone patterns are formed by concave strips with a chevroned cross section, two neighboring plates are contacted on concave edge points of respective concave strips crossing each other. Consequently, connected positions by the brazing solder show a point to point connection pattern so that a connected strength between the neighboring plates is low. As a result, a pressure-resistant performance of the flow paths of the heat

exchanger is not so good.

(2) Since a heat transfer area of fluid flow paths formed by the two herringbone plates corresponds to surface areas of the herringbone plates, a heat transfer area per unit volume of the heat exchanger is not so large. Consequently, a heat radiating performance of the flow paths is not so good.

(3) When the plates are brazed at a temperature more than the transformation temperature (882℃) of α-titanium, the herringbone plates are deteriorated, which means a durability of the heat exchanger is deteriorated.

And in producing the conventional titanium-made plate-type heat exchanger, since the herringbone plates are brazed over 850℃, they are deteriorated. Because when the brazing solder is heated over 850℃, sometimes the titanium-made plates are heated over the transformation temperature (882℃) of α-titanium so that these plates are deteriorated.

The present invention is carried out in order to solve the problems mentioned above, and provides:

(1) A production method of a titanium-made plate-type heat exchanger having fluid flow paths with a pressure resistant performance, an excellent heat radiating performance and an excellent durability;

(2) A method to produce a titanium-made plate-type heat exchanger capable of preventing titanium members constituting the fluid flow path from deteriorating due to over-heating.

[Disclosure of the Invention]

A titanium-made plate-type heat exchanger provided by the present invention in which flow paths of a first fluid and a second fluid are alternately arranged such that heat can be exchanged between the two fluids and respective flow paths are formed by connecting titanium plates; the heat exchanger comprises a flat container having an inlet of one of the fluids formed on one end and an outlet of the fluid formed on the other end; an offset-type titanium plate fin connected to the titanium plates on its both

sides and accommodated in the flat container between the inlet and the outlet, wherein: the titanium plate fin and the titanium plates are connected by a Ti-Zr type brazing solder, which melts under 880℃, containing 20 to 40 wt.% of titanium and 20 to 40 wt.% of zirconium.

And a production method of a titanium-made plate-type heat exchanger provided by the present invention in which flow paths of a first fluid and flow paths of a second fluid alternately arranged such that heat can be exchanged between the two fluids, wherein the production method for forming the flow paths by connecting a titanium-made flat container having an inlet of one of the fluids formed on one end and an outlet of the fluid formed on the other end to an offset-type titanium plate fin accommodated in the flat container and connected to the inner side of the container via top ends of concave strips of the titanium plate fin so as to form a plane to plane connection, comprises steps of: coating a brazing paste over positions to be connected of said constituting members by using a paste supply machine, wherein the brazing paste is prepared by atomizing an alloy comprising a Ti-Zr type brazing solder, which melts under 880℃, containing 20 to 40 wt.% of titanium and 20 to 40 wt.% of zirconium so as to obtain a powdered alloy, which is mixed with a neutral binder so that the brazing paste is prepared; and heating said brazing solder coated constituting members under 880℃ in an vacuum and/or inert gas atmosphere (hereinafter referred as “production method of heat exchanger”).

In the heat exchanger by the present invention, since top ends of parallel concave strips constituting a pattern of the titanium plate fin constitute a plane which contacts the titanium plate in a plane to plane relation, the titanium plate fin and the titanium are connected by the brazing solder in the form of the plane to plane connection. Consequently, a connected area between the titanium plate and the titanium plate fin is enlarged so that a connected strength is raised.

In the titanium plate fin, the concave strips constituting the pattern of the titanium plate fin show an offset arrangement. Namely, both walls of

the concave strip T having a trapezoidal cross section are bent inside with a predetermined pitch. Consequently, a surface area of the titanium plate fin is enlarged so that a heat transfer area of the heat exchanger per unit area is raised.

Further, since a connection between the titanium plates and a connection between the titanium plate and the titanium plate fin are attained

by using the brazing solder which melts under 880℃, namely under the transformation temperature (882℃) of α-titanium, the above-mentioned titanium plates to be connected are not heated over 880℃. As a result, both titanium plates are not deteriorated due to over-heating.

And in the production method of the heat exchanger by the present invention, since the connection between the titanium plates and the connection between the titanium plate and the titanium plate fin are attained by using the brazing solder which melts under 880℃, the above-mentioned titanium plates to be connected are not heated at the transformation temperature of α-titanium, when brazed. As a result, the production method by the present invention can prevent both titanium plates from being deteriorated due to over-heating.

Particularly, the production method by the present invention employs the paste-type brazing solder, since alloys used for the brazing solder by the present invention have high hardness and very low malleability, they can not be obtained in the form of a plate or a bar. Therefore the alloys are atomized in Ar gas atmosphere to obtain powdered alloys, which are mixed with the neutral binder to obtain the paste, which is supplied as the brazing solder to portions to be connected by utilizing the paste supply machine.

[Brief Description of the Drawings]

FIG.1 is a perspective view schematically illustrating an arrangement of the titanium-made plate-type heat exchanger obtained by a preferred production method by the present invention.

FIG.2 is an exploded perspective view of the titanium-made plate-type heat exchanger shown in FIG.1.

FIG.3 is a perspective view of the titanium-made plate-type heat exchanger in FIG.2 viewed from the opposite direction.

FIG.4A is a plan view of first unit plate and FIG.4B is a plan view of the second unit plate in FIG.3.

FIG.5 is a perspective view illustrating main portions of titanium

plate fins in FIG.4.

[Best Preferred Embodiments by the Present Invention]

Hereinafter the embodiment by the present invention is explained as referring to drawings

FIG.1 is a view schematically illustrating the arrangement of the titanium-made plate-type heat exchangers (hereinafter referred as “heat

exchanger") obtained by the production method of the preferred embodiment.

As shown in FIG.1, flow paths B, D and F for a first fluid X and flow paths A, C, E and G for a second fluid Y are alternately arranged so that heat is exchanged between the two fluids X and Y.

The first fluid X flows into the flow paths B, D and F from respective inlets 1 and flows out from respective outlets 2. The second fluid Y flows into the flow paths A, C, E and G from respective inlets 3 and flows out from respective outlets 4.

A reference numeral "5" is passages for the fluid X arranged in the flow paths A, C and E and communicated with the inlets 1. A reference numeral "6" is passages for the fluid X arranged in the flow paths A, C and E and communicated with outlets 2.

A reference numeral "7" is passages for the fluid Y arranged in the flow paths B, D and F and communicated with the inlets 3. A reference numeral "8" is passages for the fluid Y arranged in the flow paths B, D and F. Reference numerals "9" and "10" are shut-off paths arranged in the flow path G.

FIGs.2 and 3 are exploded views of the above-mentioned heat exchanger.

As shown in FIGs.2 and 3, the heat exchanger is constituted in the following manner. First unit plates (hereinafter referred as "first unit") U_1 and second unit plates (hereinafter referred as "second unit") U_2 are alternately layered and connected each other. Bosses 11, 12, 13 and 14 are attached to the front end second unit U_2 and a cover plate P is attached to the back end second unit U_2.

As shown in FIGs.4A and 4B, the first and second units U_1 and U_2 are respectively constituted by titanium plates 15 having upright peripheral walls 15a around, titanium guide plates 16, 16 arranged at both longitudinal ends of the titanium plates and two titanium plate fins 17 arranged between the titanium guide plates 16, 16.

Two holes 18 are arranged at each end of the titanium plate 15 so that

four holes 18 are symmetrically arranged on both ends of the titanium plate.

walls 15a of the respective titanium plates. The titanium plate fin 17 is connected with the titanium plate 15 via top end of the concave strip T. The both sides of the titanium guide plate 16 are connected to the titanium plates 15. The above-mentioned respective connected portions are connected in the form of plane to plane connection.

The holes 18 of the titanium plate 15 and the holes 19 of the titanium guide plate 16, which form passages (the passages 5 to 8 in FIG.1) for the fluids, are connected via peripheral portions of the respective holes.

The heat exchanger by the embodiment is produced in the following manner.

(1) A brazing solder is coated on the portions to be connected of the first units U_1, second units U_2, the cover plate P and the bosses 11 to 14, and then coated members with the brazing solder are assembled so that a heat exchanger assembly is prepared.

For example, one of the brazing solders shown in TAB.1, which melt under 880℃, is used as a brazing solder.

Both brazing solders contain mainly titanium and zirconium. In other words, Ti-Zr alloys are employed as the brazing solders. TAB.1 indicates that a brazing solder containing no Ni metal such as No.1 product can be used as a brazing solder and rather small amount of Cu metal is required as a constituent of the brazing solders.

TAB.1

Product #	Composition (wt.%)				Melting Point (℃)
	Ti	Zr	Cu	Ni	
No.1	37.5	37.5	25	0	820 – 840
No.2	37.5	37.5	15	10	810 – 830

Since the products in TAB.1 have high hardness and very low malleability, they can not be obtained in the form of a plate or a bar. Consequently, in order to employ the products as a brazing solder, they are atomized in argon gas atmosphere to obtain powdered products, which are

mixed with a neutral binder to obtain a paste, which is supplied as the brazing solder to portions to be connected by utilizing a paste supply machine.

Then the prepared heat exchanger assembly is placed in a vacuum heating furnace and heated gradually after the pressure in the furnace is